**NAME (as it appears on your UF ID): _____**
(Please **PRINT**)

**UF Student ID#: _____**

---------- CEN 6070 Software Testing & Verification ----------

Exam 1 -- Summer 2015

You have 90 minutes to work on this exam. It is a "closed-book/closed-notes" test. Pay attention to point values, since you may not have time to work all 20 problems. PRINT your name and UF ID# above NOW and sign the pledge at the bottom of the last page, if appropriate, when you are finished.

PLEASE PRINT **– do NOT write *cursively* –** ANSWERS IN THE SPACE PROVIDED ONLY, PREFERABLY USING A BALLPOINT PEN (electronic or otherwise!) TO INCREASE LEGIBILITY. Good luck!

1. (6 pts.) Briefly define and explain the relevance of each of the following terms/acronyms used by Ken Johnston in his Guest Lecture, "The Future of Testing is EaaS*y*."

   a. BUFT

   b. LKGC

2. (3 pts.) Joseph Cutrono used the term "journey test" when comparing and contrasting unit testing, acceptance tests, and UI tests in his Guest Lecture. Briefly describe what he meant by "journey test".

3. As discussed in class, a distinction is normally drawn between the terms *functional testing* and *structural testing.*

   a. (4 pts.) Describe this distinction.

   b. (2 pts.) How do functional and structural testing differ in terms of the source for test case "expected results?" (Identify the source for each approach.)

   c. (3 pts.) Explain why it is typically considered to be potentially more efficient to undertake functional testing BEFORE undertaking structural testing.

4. (9 pts.) Briefly define each of the following software testing-related terms.

   a. beta testing:

   b. soak testing:

   c. system test acceptance:

5. (4 pts.) Reference was made in class and in the lecture notes to a Feb. 3, 2010 Bloomberg article about Toyota having ruled out electronics as a cause of sudden acceleration that had resulted in recalls of millions of its cars and trucks. Which one of the following points was this article used to illustrate? (Choose ONE only.)

   a. Test cases must be written for INVALID and UNEXPECTED, as well as valid and expected, input conditions.

   b. The owners of cars with electronic throttle systems have yet to fully embrace testing models that call for developers to "become comfortable with testing less and knowingly shipping buggier software faster than ever before."

   c. In general, the probability of the existence of more errors in a section of a program is directly related to the number of errors already found in that section.

   d. Programmers should in principle avoid testing their own programs.

   e. It is important to test system versions over a significant period of time to discover latent errors or performance problems (due to memory leaks, buffer/file overflow, etc.)

   f. (None of the above)

6. Suppose a function that returns either a Boolean value or one of two possible error messages has 3 inputs, each comprised of 2 disjoint attribute classes, with no infeasible input combinations.

   a. (6 pts.) What is the minimum number of test cases needed to achieve *"Strong Equivalence Class Testing"*? What is the minimum number needed to achieve *"Weak Equivalence Class Testing"?*

      minimum # of cases needed for *strong equivalence class testing:* _____

      minimum # of cases needed for *weak equivalence class testing:* _____

   b. (3 pts.) Joseph Cutrono, in his Guest Lecture, described another combinatorial testing criterion called "all-pairs." What is the minimum number of test cases needed to achieve *"All-Pairs Equivalence Class Testing"?*

      minimum # of cases needed for *all pairs equivalence class testing:* _____

   c. (3 pts.) Suppose a given implementation of this function has a total of 7 execution paths, five of which are feasible. If the function's 3-dimensional input space is partitioned solely on the basis of specified output, what is the minimum number of test cases needed to ensure coverage of the partitions?

      minimum # of cases needed to cover the partitions: _____

7. Recall from Lecture Notes 6.1 ("Case Study: Black-Box Testing") the application of black-box test case design techniques to the power function pow(x,y).

   a. (4 pts.) What, specifically, were the two SOURCES of information used in support of modeling pow error Effects?

   b. (4 pts.) Briefly describe the approach used to model non-error Effects?

   c. (4 pts.) Using a **number line** representing the exact value of $x^y$, clearly identify ALL region(s) on the line associated with UNDERFLOW and OVERFLOW conditions for pow(x,y).

8. (6 pts.) For a nominally complete and consistent Cause-Effect model, which, if any, of the following coverage criteria/conditions would necessarily be satisfied as a result of employing "test case selection strategy #3"? Indicate "would" or "would not" as appropriate. To compensate for random guessing, your score in points will be 2 times the number of [correct minus incorrect] answers, or 0 – whichever is greater. Therefore, if you are not more than 50% sure of your answer, consider skipping the item.

| | | |
|---|---|---|
| a. AFCCV coverage | would | would not |
| b. AE coverage | would | would not |
| c. all feasible combination of Effect values | would | would not |

9. (8 pts.) Consider pseudocode program:

```
(1) input (A,B);
(2) if (A OR B) then
(3)      s1
(4) end_if
```

for Boolean variables A, B. PROVE, **using one or more counter-examples, as necessary**, that

path coverage and condition coverage are independent

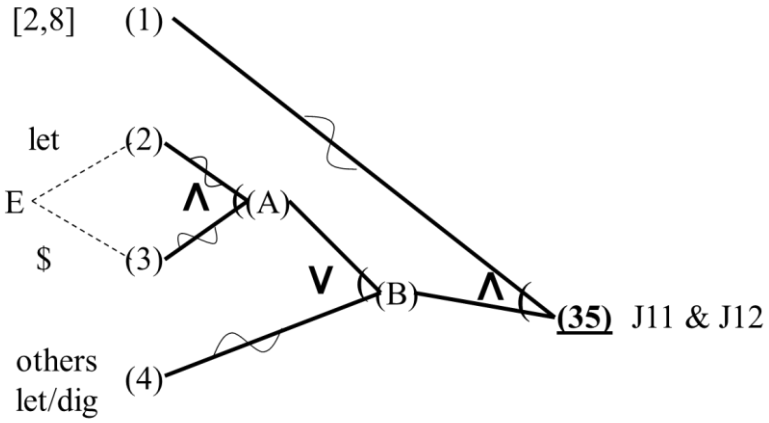
Explicitly identify any counter-example(s) used in your proof by identifying the Boolean input values assumed for A and B, the path(s) sensitized, etc. Your counter-example(s) and explanation must make your conclusion clear.

10. Several types of "higher-level tests" were described in class. One of these was "Serviceability test."

    a. (3 pts.) What is the focus or purpose of serviceability test?

    b. (4 pts.) Three general areas/elements that would normally be covered by serviceability test were discussed in class. One of these was "change procedures" (for adaptive, perfective, and corrective service scenarios). What were the other two?

11. a. (3 pts.) How many test case templates (i.e., columns in the test case coverage matrix) were associated with Effect 35 ("error messages J11 AND J12 are output") being TRUE in the Symbol Table Storage Specification Cause-Effect Example covered in class? (Hints: the Cause-Effect graph for Effect 35 is shown below. The test case coverage matrix was to reflect all feasible combinations of connected Causes resulting in each Effect being TRUE as represented in the Cause-Effect graph(s), subject to the Culling Rules described in class. "E" stands for "Exclusive" = at most one.)




**Number of test case templates**: ___

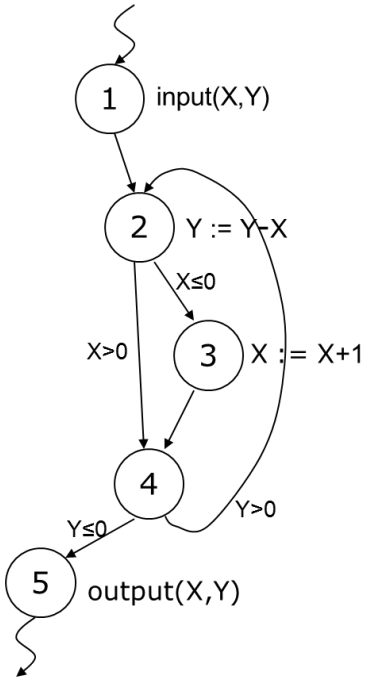
b. (3 pts.) Suppose the coverage criteria was as in part (a) but **NOT** subject to the Culling Rules. How many test case templates would be associated with Effect 35 being TRUE in that case?

**Number of test case templates if Culling Rules were NOT used**: ___

12. (6 pts.) After just 2 days of testing a new product release, John announced to the team that there were approximately 10 "bugs" left in the program. Amazed by this projection, Janice said, "Well, we've already found 40 errors in just 2 days. What makes you think that there are only 10 left?" John replied, "Well, 30 of those 40 errors weren't really "bugs" – they were errors that I seeded into the system before testing started. So, I figure that there should only be about 10 REAL bugs left to find now."

Assuming John used the error seeding technique discussed in class, how many errors did John "seed" into the system before the team started testing?

13. (28 pts.) Consider the program control flow graph below.




a. Identify ALL **(and ONLY)** the du-pairs for variable X.

b. Identify ALL **(and ONLY)** the du-pairs for variable Y.

c. Identify all **(and ONLY)** the feasible du-paths associated with du-pair (2,<4,2>) for variable Y.

d. Identify all **(and ONLY)** the feasible du-paths associated with du-pair (3,5) for variable X.

(continued on next page)

13. e. What is the total number of test cases, at the minimum, that would be required to achieve each of the following for this program? (Circle one only for each.)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| i. *All-Defs coverage:* | 1 | 2 | 3 | 4 | 8 | 16 | infinite |
| ii. *Branch coverage:* | 1 | 2 | 3 | 4 | 8 | 16 | infinite |
| iii. *All-Uses coverage:* | 1 | 2 | 3 | 4 | 8 | 16 | infinite |
| iv. *Basis-Paths coverage:* | 1 | 2 | 3 | 4 | 8 | 16 | infinite |

f. Give the complete *path condition* for path <1,2,3,4,2,3,4,5> in terms of the **input values** of variables X and Y. (Do not combine or otherwise simplify predicates.)

g. Give an example of initial values for X and Y, if any, that would satisfy the path condition for the path given in part (f). If none, write "none".

14. (7 pts.) Match each description below to the **SINGLE MOST APPROPRIATE TERM** related to testing object-oriented software among the following. (Note: terms may apply to none, one, or more than one description.)

| | |
|---|---|
| A. encapsulation | G. polymorphism |
| B. inheritance | H. observability interfaces |
| C. unit level O-O testing | K. state machine models |
| D. object classes | L. methods |
| E. use/include relations | M. UML sequence or collaboration diagrams |
| F. higher level O-O testing | N. inspection operations |

___ Object-oriented design principle that may necessitate the use of special instrumentation to interpret the effects of methods

___ Allows object classes to be *specialized* or *extended* from one or more other object classes

___ Sometimes required by design rules to circumvent the problem of object state not being directly accessible, but results in some overhead

___ Allows variable types and method bindings to change dynamically, thus requiring testers to be aware of the bindings that may occur

___ Often focuses on object classes as opposed to individual methods, as testing methods in isolation is not always practical

___ Facilitates the application of partitioning and combinatorial test case design techniques on a state-by-state basis

___ Normally begins with the integration of object classes to form inter-object class functional entities

15. (12 pts.) In "The Psychology and Economics of Program Testing," Myers identifies a number of "vital testing principles" related to important considerations in software testing. Some of these are:

A. A necessary part of a test case is the definition of the expected output or result.

B. A programmer should avoid attempting to test his or her own program.

C. A programming organization should not test its own programs.

D. The results of each test case must be thoroughly inspected.

E. Test cases must be written for invalid and unexpected as well as valid and expected, input conditions.

F. Examining a program to see if it does not do what it is supposed to do is only half of the battle. The other half is seeing whether the program does what it is *not* supposed to do.

G. Avoid throw-away test cases unless the program is truly a throw-away program.

H. Do not plan a testing effort under the tacit assumption that no errors will be found.

I. Testing is the process of executing a program with the intent of finding errors.

J. A good test case is one that has a high probability of detecting an as yet undiscovered error.

For each description below, identify the single principle from among those listed above that Myers is describing. (Enter the letter of the principle being described to the left of the description.)

____ *This principle follows from earlier discussion in the chapter, principally the discussion that implied that testing is a destructive process. ...As many homeowners know, removing wall-paper (a destructive process) is not easy, but it is almost unbearably depressing if you, rather than someone else, originally installed it. ...In addition...there is a second significant problem: The program may contain errors due to the programmer's misunderstanding of the problem statement of specification...*

____ *Quoting the logician Copi: A problem may be characterized as a fact or group of facts for which we have no acceptable explanation, which seem unusual, or which fail to fit in with our expectations or preconceptions. It should be obvious that some prior beliefs are required if anything is to appear problematic. If there are no expectations, there can be no surprises.*

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15. (cont'd)

_____ *In most environments, a...project manager is largely measured on the ability to produce a program by a given date and for a certain cost. One reason for this is that it is easy to measure time and cost objectives, but it is extremely difficult to quantify the reliability of a program. ...The testing process, if approached with the proper definition, may be viewed as decreasing the probability of meeting the schedule and cost objectives.*

_____ *This problem is seen most often in the use of interactive systems to test programs. A common practice is to sit at a terminal, invent test cases on the fly, and then send these test cases through the program...*

16. (12 pts.) In *"The six essentials of software testing,"* Edward Kit describes "the essentials of the software testing process that serve as the foundation" for his book, Software Testing in the Real World: Improving the Process. For each of the following "essentials", **circle the missing word(s)** actually used by Kit from among the options given.

a. **Cultivate a positive team attitude of _____.** (goodwill toward man; creative destruction; invincibility; existential grandeur).

b. **The quality of the _____** (tester; test plan; test process; test cases) **determines the success of the test effort.**

c. **Testing is a professional discipline requiring _____.** (trained, skilled people; disciplined self-deprivation, a good sense of humor, good intuition).

d. **Prevent defect migration by using _____** (information hiding; early life-cycle testing techniques; regression testing; black-box testing) **techniques**.

e. **A real person must take responsibility for _____.** (test planning; software quality; maintaining test cases; improving the testing process).

f. **The time for _____** (formal methods; continuous process improvement; software testing tools; tester training) **is now.**

17. (4 pts.) In their paper, *Key Lessons in Achieving Widespread Inspection Use,* Grady and Van Slack motivate their story about the software inspection adoption process at Hewlett-Packard with an anecdote that illustrates the enormous potential return on investment (ROI) that can be achieved with some types of inspections. Which one of the following was the subject of the anecdote given? (Circle ONE only.)

    a. Before buying a recently refurbished vintage sports car, one of the authors decided to invest in a $100 inspection of the car's crankshaft, despite assurances that it had recently been replaced. It turns out that the wrong part had been used during refurbishment, and that the engine would have likely been destroyed after just a few hours of use.

    b. The authors refer to an industry survey from 1985 that showed it is 100 times more expensive to correct errors discovered during "installation" than when discovered using inspections during "analysis."

    c. Before buying a used house, one of the authors and his wife decided to pay $25 for an inspection of the house's hot water based heating system. It turned out that the water pipes were leaking and the system had to be replaced at great expense – by the sellers.

    d. The authors describe the experience of one organization within HP that reported an average cost of $91 per defect found during "inspections" versus $25,000 per defect found after product delivery.

    e. Before bringing a new hydroelectric power plant on-line for the first time, a $200 inspection of a generator bearing resulted in finding a previously undetected crack that would have resulted in the likely destruction of a $200,000 turbine.

    f. (none of the above)

18. (4 pts.) In their paper, *The Effectiveness of Software Development Technical Reviews: A Behaviorally Motivated Program of Research,* Sauer, et al. apply the behavioral theory of group performance to explain the outcomes of software reviews. Which one of the following, according to the authors, is the "most salient (i.e., important) finding" of the empirical research in which the theory is based? (Circle ONE only.)

    a. That group performance is dominated by the available task expertise.

    b. That decision schemes (plurality effects) dominate interacting group performance.

    c. That synergy is the primary reason why groups perform better than individuals.

    d. That group performance is a positive function of task training.

    e. That the performance advantage of an interacting group over a nominal group is a function of the level of false positives discovered by individuals.

19. (12 pts.) In their chapter, *"Making Meetings Work for Everyone,"* Gause and Weinberg offer several observations and recommendations related to making meetings more productive. For each of the following, circle "is" if the observation or recommendation is included in the chapter, and "is not" otherwise. To compensate for random guessing, your score in points will be 2 times the number of [correct minus incorrect] answers, or 0 – whichever is greater. Therefore, if you are not more than 50% sure of your answer, consider skipping the item.

| | | |
|---|---|---|
| a. If a project seems to hold too many meetings, it may be a symptom of overstaffing. | is | is not |
| b. A good reason to get agreement on prohibiting personal attacks or put-downs at the *calm beginning of a meeting* is that nobody will ever object to this at that point in time. | is | is not |
| c. One important device for staying out of emergency mode is the time-out, when meeting participants agree in advance that anyone can call one-minute or five-minute time-outs at any point without explaining why. | is | is not |
| d. Limiting meetings to no more than 3 agenda items keeps them small, short, and relevant to all in attendance. | is | is not |
| e. Organizations promote the model of developers working independently (via such devices as individual achievement awards) because in any *sizable* development project, it is well know that relying on competent individuals working alone is the most reliable way to achieve extraordinary outcomes. | is | is not |
| f. To help prevent the problem of people coming to meetings they should **not** attend, be sure that only invited participants are offered refreshments. | is | is not |

20. (9 pts.) Match each description below to the **SINGLE MOST APPROPRIATE TERM** among the following. (Note: terms may apply to none, one, or more than one description.)

| | |
|---|---|
| A. Fault-based test | L. "Soak" test |
| B. Installability test | M. Device and configuration test |
| C. Thread test | N. Usability test |
| D. Alpha test | O. Serviceability test |
| E. Performance test | P. Beta test |
| F. Stress test | R. Security test |
| G. "Lights out" test | S. "Smoke" test |
| H. Regression test | T. Exhaustive test |
| I. Reliability test | U. Compatibility/conversion test |
| J. Post-test analysis | W. Causal analysis |
| K. Benchmarking | X. Test-driven development |

___ Issues of focus include login and password procedures and policies, levels of authorization for data or procedural access, etc.

___ Testing which covers every possible combination of a program's input values

___ Specialized testing in which HCI experts conduct experiments and utilize protocol analysis

___ General practice of recording and comparing indices of performance, quality, cost, etc., to help identify "best practices"

___ Process aimed at identifying the origin of errors and approaches to eliminate future occurrences

___ Integrating program elements associated with a key program function

___ Focus is on typical requirements that systems exhibit "graceful" failures and non-abrupt performance degradation

___ Automated, stand-alone testing not requiring human involvement

___ Development process characterized by writing (and running) tests for new increments of functionality *before* they are implemented

On my honor, I have neither given nor received unauthorized aid on this exam and I pledge not to divulge information regarding its contents to those who have not yet taken it.

_____
SIGNATURE